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MODULAR, VERTICALLY-INTEGRATED MANUFACTURING METHOD FOR A LAWN AND GARDEN IMPLEMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 U.S.C. §119(e) of United States Provisional Application No. 60/272,892, filed March 2, 2001 and United States Provisional Application No. 60/289,434, filed May 8, 2001.

BACKGROUND OF THE INVENTION

1. Field of Invention

[0002] The present invention relates to the manufacture of small utility or lawn and garden implements, such as snow throwers, mowers, and tillers, for example, which include among other components, an engine, a transaxle, and a clutch and steering mechanism.

2. Description of the Related Art.

[0003] Small utility or lawn and garden implements, such as snow throwers, mowers, and tillers, generally include an engine for supplying mechanical motion to a working device and also to a transaxle, which in turn transfers the mechanical motion to ground engaging wheels to drive the implement. Typically, the engine and the transaxle are manufactured separately from one another.

[0004] Typically, implements 20, such as snow thrower 22 (Figure 2A-2B) and lawnmower 23 (Figure 3) are manufactured by a process shown schematically in Figure 1, in which engine 24 is manufactured at a first manufacturing facility 44 by an engine manufacturer, transaxle 26 is manufactured at a second manufacturing facility 46 by a transaxle manufacturer, and engine 24

and transaxle 26 are then separately shipped or transported to third manufacturing facility 48 for final assembly of implement 20 by an implement manufacturer. First, second, and third manufacturing facilities 44, 46, and 48 may be located remote from one another. The term "remote", as used herein, refers to the distance between manufacturing facilities, wherein it is contemplated that manufacturing facilities which are remote from one another are separate from one another, and may be located either close to one another or a great many miles away from one another, but where the facilities are not located within the same building or comprise two sections of a common assembly line.

[0005] Often, the engine manufacturer, the transaxle manufacturer, and the implement manufacturer are three separately owned and operated manufacturing entities. At third manufacturing facility 48 of the implement manufacturer, engine 24 and transaxle 26 are connected to one another, and additional components of implement 20, such as wheels 32, handle 30 and working device 28, are additionally connected to engine 24 and/or transaxle 26 to substantially complete the assembly of implement 20. From third manufacturing facility 48 of the implement manufacturer, implement 20 is shipped or transported to retailer/dealer 50, where implement 20 is ultimately sold to consumer 52.

[0006] There are several problems with this approach to manufacturing implement 20, however. For example, from the viewpoint of the implement manufacturer, separate, perhaps non-interchangeable engines and transaxles require maintenance of a very large inventory of both engines and transaxles. Further, the implement manufacturer must perform the additional manufacturing operation of connecting the correct engines and transaxles to one another, which increases labor and assembly costs for the implement manufacturer.

[0007] Additionally, if the implement manufacturer desires engines of different sizes and/or output shaft orientations, and/or transaxles of different types, the implement manufacturer must ensure that the engines and transaxles are operatively compatible with one another, to coordinate the transporting of the engines and transaxles to its facility, and to make sure that the engines and transaxles are delivered on schedule, which requires the implement manufacturer to expend significant resources dealing with each of the engine manufacturer and the transaxle manufacturer.

[0008] Additionally, this method may not allow interchangeable parts to be used. Rather, the engine selected, i.e. engine A, may only fit one transaxle, i.e. transaxle A, thereby preventing the assembly of different modules utilizing different parts. Ideally, instead of using only engine A with transaxle A, engine A would be used with transaxle B and engine B with transaxle A, and so forth utilizing a wide range of engines and transaxles. A manufacturing system which would allow a selection of any transaxle and any engine to create a module would be desirable.

[0009] From the viewpoint of each of the engine and transaxle manufacturers, the need to design and manufacture many specific engines and transaxles which are compatible with certain other respective engines or transaxles in order to suit the needs of multiple implement manufacturers is undesirable and costly. However, the ability of having different engines being compatible with many different transaxles and vice versa would allow the engine and the transaxle manufacturers to manufacture engines and transaxles without the requirement of suiting the needs of multiple implement manufacturers.

[0010] What is needed is a method for manufacturing small utility or lawn and garden implements, which is simplified and versatile as well as allowing for the interchangeability of parts and the creation of modules from the different parts selected.

SUMMARY OF THE INVENTION

[0011] The present invention provides a method of manufacturing an implement, including providing a first group of engine types and a second group of transmission types at a common, first manufacturing facility, selecting a desired module configuration, selecting a desired engine from the first group and a desired transmission from the second group, connecting the selected engine and transmission together in the desired module configuration to provide a base of the implement, transporting the base to a second facility, providing a working device at the second facility, and connecting the working device to the base at the second facility.

[0012] The present invention further provides a method of manufacturing an implement, including providing a first group of engine types, a second group of transmission types, and a third group of steering mechanism types at a common, first manufacturing facility, selecting a desired module configuration, selecting a desired engine from the first group, a desired transmission from the second group, and a desired steering mechanism from the third group, connecting the selected engine, transmission, and steering mechanism together in the desired module configuration to provide a base of the implement, transporting the base to a second facility, providing a working device at the second facility, and connecting the working device to the base at the second facility.

[0013] The present invention also provides that the first group includes vertical shaft engines and horizontal shaft engines of various displacement, the second group includes hydrostatic transaxles, manual shift transaxles, and friction drive transaxles, and the third group includes a spring clutch and trigger actuated steering mechanism and an intuitive steering mechanism. The

working device includes an auger assembly, a cultivating blade assembly, or a mower blade assembly.

[0014] An advantage of the inventive method of producing an implement is that the usage of different parts to create various combinations, or modules, is promoted. Rather than rely on a single engine being attached to a single transaxle or steering mechanism, or a one-to-one relationship between engines and transaxles or steering mechanism, all of the parts required for the implement may be interchanged to provide implement bodies with different qualities. Further, the inventive method promotes vertical integration, thereby facilitating assembly process control by a single entity and reducing costs of manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

[0016] Figure 1 is a schematic representation of a previous method of manufacturing implements such as the snow throwers of Figures 2A and 2B and the lawnmower of Figure 3;

[0017] Figure 2A is a perspective view of an exemplary previous implement which may be manufactured in accordance with the method of the present invention, the implement is shown as a snow thrower;

[0018] Figure 2B is a side view of another exemplary previous implement which may be manufactured in accordance with the present invention, the implement is shown as a snow thrower similar to the snow thrower of Figure 2A;

[0019] Figure 3 is a perspective view of an exemplary previous implement which may be manufactured in accordance with the method of the present invention, the implement is shown as a lawnmower;

[0020] Figure 4 is a perspective view of the engine and transaxle module of the implement of Figure 2A;

[0021] Figure 5 is a top plan view of a transmission showing engagement of a drive belt with an output pulley of a power source and corresponding to a pivot arm position which provides the greatest axle speed;

[0022] Figure 6 is a perspective view of one embodiment of a friction drive transaxle;

[0023] Figure 7 is a perspective view of one embodiment of a hydrostatic transmission;

[0024] Figure 8 is a schematic view of a first embodiment of a manual gear shift transaxle incorporating an epicyclic steering mechanism;

[0025] Figure 9 is a schematic view of a second embodiment of a manual gear shift transaxle incorporating a ball and collar steering mechanism;

[0026] Figure 10 is a schematic view of a generic clutch in conjunction with an engine and a transaxle;

[0027] Figure 11A is a sectional view of a spring clutch used in conjunction with a trigger actuated steering mechanism;

[0028] Figure 11B is a perspective view of the spring clutch of Figure 11A;

[0029] Figure 12 is a view of the bi-directional wheel clutch used in conjunction with an intuitive steering mechanism;

[0030] Figure 13 is a view of the clutch of Figure 12 in the neutral position;

[0031] Figures 14A and 14B are views of the clutch of Figure 12 in the two respective engaged positions;

[0032] Figure 15 is a flowchart depicting a process of manufacture in accordance with the present invention;

[0033] Figure 16 is a flow diagram depicting module configurations and the relationship between the configurations in accordance with the inventive method; and

[0034] Figure 17 is a diagram of the relationship between the manufacturing facilities.

[0035] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one embodiment of the invention and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION

[0036] For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended.

[0037] Existing implement 20 is shown in Figures 2A-3, and is representatively shown as snow thrower 22 (Figures 2A-2B) and lawnmower 23 (Figure 3), similar to that disclosed in U.S. Patent Application Serial No. 09/785,431, now issued U.S. Patent No 6,643,959 filed February 16, 2001, the disclosure of which is expressly incorporated herein by reference. As shown in Figures 2A-3, implement 20 includes engine 24, transmission 26 attached to engine 24, working device 28, handle 30 (of which two embodiments 30a and 30b are shown), and wheels 32. Implement 20 also includes a steering

mechanism by which the operator may easily control turning of the implement. It should be noted that transmission 26 may be a transaxle, therefore the terms transaxle and transmission are used interchangeably within this disclosure.

[0038] As shown in Figure 2B, engine 24 includes output shaft 34 connected by drive linkage 36 which is shown in Figure 2B as a pair of flexible belts, for example, to each of input shaft 38 of transaxle 26 and input shaft 40 of working device 28. Engine 24 is shown in Figures 2A and 2B as a horizontal shaft engine for use in a horizontal shaft application; however, in accordance with the method of the present invention, vertical shaft engines may also be accommodated as required by the implement design. Additionally, the inventive method accommodates two-stroke or four-stroke engines, or engines of different displacements as desired.

[0039] Transaxle 26 may be of any known type, such as a gear-driven transaxle having a fluid brake and epicyclic gear arrangement or a plurality of manually-shifted gears therein which control the speed of the implement. For example, transaxle 26 may be of the basic type disclosed in U.S. Patent No. 5,971,881, issued October 26, 1999, the disclosure of which is expressly incorporated herein by reference. A variable speed, reversible transmission utilizes two pumps for variably controlling the speed of the output shaft or axle. A rotatable input member is connected to a drive source which drives first and second epicyclic gear trains that, in turn, drive two pumps, and as fluid flow through each pump is variably restricted, thereby braking the respective ring gear of each epicyclic gear train, the planet gears linked to an output member revolve about the input member or sun gear to cause the output member to rotate in a forward or reverse direction. Alternatively, transaxle 26 may be of the known type and basic

design exemplified by commercially available 1300, 2500 or 2600 Series transaxles manufactured by Tecumseh Products Company.

[0040] Transaxle 26a of Figure 5 includes a pair of belts 62, 64 respectively engaged with a pair of pulley assemblies at three respective variable radial positions of engagement between each belt and pulley. Pivot pulley assembly 58 is rotatably attached to a selectively rotatable pivot arm pivotably supported by a housing, and transmission pulley assembly 60 is rotatably attached to a drive member rotatably supported within the housing and selectively engageable with axle 42. Transmission belt 64 is initially engaged with pivot pulley assembly 58 at a first radial position and is initially engaged with transmission pulley 60 at a second radial position. Additionally, drive belt 62 is initially engaged with second pulley 59 at a third radial position. Each of the radial positions is variable and may be varied by movement of the rotatable pivot arm. As the pivot arm moves pivot pulley assembly 58 toward second pulley 59, the distance between pulley 59 and pulley assembly 58 becomes less while the distance between transmission pulley assembly 60 and pulley 59 becomes greater. The change in distances allows the pulley halves of pulley 59 to come closer, increasing its diameter and changing the radial position of belt 62, while belt 64 becomes tighter, causing belt 64 to separate the pulley halves of pulley 60, reducing its diameter and changing the radial position of belt 64. The pulley halves of pulley assembly 58 may be separated or allowed to move closer together depending upon the change in the radial positions of belts 62 and 64 in conjunction with pulley 59 and pulley assembly 60. It should be noted that transaxle 26a of Figure 5 is utilized with vertical shaft engines, whereas transaxles 26b-26e, described hereinbelow, are used with horizontal shaft engines. As the inventive manufacturing method allows greater flexibility in manufacturing, vertical shaft engines may be used as easily as horizontal shaft engines.

[0041] Referring to Figure 6, transaxle 26b may be a friction drive transaxle including first friction disk member 112, which is driven by engine 24, and second friction disk member 114 driving input shaft 38 of transaxle 26b and rotatable about an axis having an axis of rotation perpendicular to that of first friction disk member 112. Friction disk member 114 is radially movable to driveably engage first friction disk member 112 and axially moveable to vary the axle speed. Axial movement of member 114 past the center of rotation of member 112 reversely drives axle 42.

[0042] Transaxle 26c may also be a hydrostatic transaxle, such as that disclosed in U.S. Patent No. 6,151,990, issued November 28, 2000, or U.S. Patent Application Serial No. 09/498,692, filed February 7, 2000, the complete disclosures of which are expressly incorporated herein by reference. Such transaxles 26c, one of which is shown in Figure 7, include pump 106 driven by input shaft 38 thereof which is fluidly connected to motor 108 having output shaft 110 for driving axle 42.

[0043] Axles 42 of transaxle 26d are in driving engagement with ground engaging wheels 32. Transaxle 26d, as shown in Figure 8, may include a geartrain with first and second epicyclic gear arrangements 54, each of which are selectively drivingly coupled to only one of axles 42, independently of the other axle, such that neither, only one, or both of the axles are drivingly coupled to the geartrain. Each epicyclic gear arrangement is surrounded by a band brake which is individually, operatively connected to a trigger 130 on each grip of handle 30 of implement 20.

[0044] Referring to Figure 9, transaxle 26e includes a manual gear shift, or a key-shift, transmission which is used in conjunction with hub assemblies 56, described hereinbelow, to propel an implement. As is known, a key-shift transmission includes a multiplicity of gears representing different operating speeds, and one of which is selected by the operator through a

speed selector and movement of a fork disposed within the shaft upon which the gears are mounted.

[0045] Referring to Figure 3, trigger operated steering allows the implement to be propelled by the operator's releasing one or both of a pair of triggers 130 mounted on the left and right grips of its handle 30b. Handle 30 may include a single grip structure for grasping, such as handle 30a in Figures 2A-2B has, or consist of two separate grip portions for grasping, such as handle 30b of Figure 3 has. Either structure may include triggers 130, although triggers 130 are shown on handle 30b. Implement 20 is powered through turns by partially or fully engaging the trigger on the side corresponding with the direction of the turn. Full engagement of trigger 130 disengages driving power to wheel 32 on the selected side, while partial engagement restricts the driving power to wheel 32 on the selected side. For example, if the operator wishes to turn implement 20 to the right, the operator would at least partially engage the trigger 130 on the right side of implement 20, disengaging driving power to the right wheel. Meanwhile, wheel 32 on the left side of implement 20 remains powered and becomes the driving wheel, thereby causing implement 20 to turn to the right by using the right wheel as an axis of rotation. Triggers 130 may be attached to a cable or other linkage device for operating a clutch mechanism, such as the torsion spring friction clutch, described hereinbelow, or for operating a band brake mechanism (Figure 8), described above or a shift collar mechanism (Figure 9), described hereinbelow.

[0046] Alternatively, transaxle 26e, as shown in Figure 9, may include a single axle operatively coupled to the geartrain about which are disposed two hub assemblies 56, each of which extends from the casing and is selectively engaged with axle 42 independently of the other hub assembly. Neither, only one, or both of hub assemblies 56 may then be coupled to axle 42. A trigger 130 located on each grip of handle 30b (Figure 3) is operatively connected with shift

collar 128 of each hub assembly 56 such that when a trigger is pulled, the shift collar 128, in operative communication with the pulled trigger, moves to allow independent engagement of the associated hub assembly 56 to axle 42. Such trigger actuated steering is described above.

[0047] When the base of implement 20 is assembled, it includes engine 24, transaxle 26, and steering mechanism 74, which requires handle 30 and a clutch mechanism or other functionally related mechanisms, such as the band brake mechanism or the shift collar mechanism, as described above. Additionally, steering mechanism 74 may be a trigger actuated steering means or an intuitive steering means. A portion of a generic base of implement 20 is shown in Figure 10 as including engine 24, and transaxle 26, which may be of any type described above, in module 90. To module 90 are connected axles 42 attached to generic wheel hubs 132 and wheels 32. Surrounding axles 42 are generic clutch mechanisms 134 which may be of any suitable type, such as the torsion spring friction clutches described below.

[0048] In association with trigger actuated steering, as described above, clutches 134 may be torsion spring friction clutch, located at each wheel 32, in which input hub 122 and wheel hub 120 have axially adjacent cylindrical portions about which is disposed torsion spring 96, as shown in Figure 11A. Within wheel hub 120 are a plurality of one-way roller bearings 136 which allow axle 42 to directly engage wheel hub 120 when axle 42 is reversely rotated but allow axle 42 to freely rotate in the forward direction relative to wheel hub 120. Disposed about the outer diameter of spring 96 is control collar 98. Pawl 100 (Figure 11B) is pivotally attached to implement 20 and is biased by spring 116 into engagement with one of the slots 118 in control collar 98, preventing rotation of control collar 98 in the forward direction. When a trigger 130 (Figure 3) is pulled, pawl 100 is disengaged from control collar 98 of the corresponding wheel, allowing wheel hub 120 to rotate in the forward direction. As wheel hub 120 is allowed to

rotate, the spring diameter is allowed to contract, bringing that wheel's input hub 122 and wheel hub 120 into clutched engagement through spring 96.

[0049] Intuitive steering includes a bi-directional clutch, such as the Bi-Directional Clutch designed and manufactured by the Motion Control Division of Hilliard Corporation of Elmira, New York, and is not trigger operated. With intuitive steering, a change in the direction and/or speed of the implement causes the bi-directional clutch, located at each wheel 32, to sense the change and to allow overrunning of its respective wheel 32. Sensing the change in direction and speed is accomplished with a roller ramp design which allows roller 68 (maintained within roll cage 70) to move between outer race 72 and multiple flat cams 66, as shown in Figure 12, to engage and disengage engine 24 (not shown) and transaxle 26 (not shown). In the neutral, or disengaged, position, rollers 68 are allowed to rotate freely, as shown in Figure 13. In the engaged positions, depicted in Figures 14A and 14B, rollers 68 cause engagement between inner cam 66, roll cage 70, and outer race 72. As this is a bi-directional clutch, engagement will occur when roller 68 moves in either direction.

[0050] Although exemplary engines, transmissions, clutch means and steering means have been discussed, the present invention is not limited to a method in which only these parts or these particular types of parts are processed. The process, as described hereinbelow, is applicable to the manufacture of any walk-behind implement that requires the assembly and/or combination of several parts. Therefore, other types of engines, transmissions, steering means, and clutch means would be usable in the process as well as other parts, such as handles, housings, and the like. Additionally, the process may be used to assemble single stage and multiple stage implements.

[0051] Referring to Figure 15, the inventive process of manufacture will now be discussed. At first manufacturing facility 102 several options for engine 24, transaxle 26, and steering

mechanism 74 are provided, from which the selection of the specific parts to include in implement 20 is made. Although engine, transmission, and steering mechanism possibilities are presented in the figure, any items required for the implement, including the working devices (not shown), may be provided in the selection pool. At first manufacturing facility 102, one unit of each part is selected to be included in the implement base, as seen in block 76.

[0052] The different module configurations, which are selected (block 124), will be discussed with reference to Figure 16. Two parts are connected in each module configuration 90, 92, 94 with a single module and another part being connected to provide the base of implement 20. For example, engine 24 and transmission 26, each of any type, as appropriate, are connected to create one engine and transmission module 90 while the steering mechanism 74 is maintained as a single part, with module 90 and steering mechanism 74 then being connected to create the base of implement 20. The same process applies to modules 92, 94 created by connecting engine 24 or transaxle 26 to steering mechanism 74 in other configurations as seen in Figure 16.

[0053] Referring again to Figure 15, engine 24, transaxle 26, and steering mechanism 74 are connected in the proper module configurations, as shown in block 78. Once that is done, the final connections between the modules, or a single module comprising one of engine 24 and transaxle 26 and steering mechanism 74, connected to the other of engine 24 and transaxle 26, are made to create the base of implement 20 (block 80). As first manufacturing facility 102 is used for assembly of the parts to create the base of implement 20, the base must be transported to second manufacturing facility 104 (block 82) to connect the base of implement 20 to the selected working device 28 (block 84). Referring to Figure 17, second manufacturing facility 104 may be located in a separate facility from first manufacturing facility 102, such as in the known "remote"

configuration described above, or second manufacturing facility 104 may be in the same facility as first manufacturing facility 102, as represented by the dashed lines, since manufacturing facilities 102, 104 may designate locations on a single assembly line. Additionally, first manufacturing facility 102 may include a plurality of separate facilities where portions of assembly may occur. For example, transmission 26 may be transported to an engine manufacturing facility where transmission 26 and engine 24 are assembled to form module 90, or engine 24 transported to a transmission manufacturing facility for assembly. Module 90 may then be transported to another facility for assembly with steering mechanism 74 to form the base of implement 20.

[0054] Continuing along the path provided in Figure 15, the base is transported to second manufacturing facility 104 (block 82) at which working device 28 is selected (block 84) and assembled to the base (block 86). Working device 28 may be, for example, an auger assembly, such as is used in snow thrower 22 (Figures 2A-2B), a mowing assembly, such as is used in lawnmower 23 (Figure 3), or a cultivating blade assembly, such as that used in a tiller, each of which are available at the second manufacturing facility 104. In any case, the base of implement 20 is assembled at first manufacturing facility 102, and working device 28 is connected to the base at second manufacturing facility 104 (block 86). Working device 28 includes its own drive linkage which is connected to the base of implement 20 at the same time as working device 28 (block 86), thereby providing the driving means necessary for operation of working device 28.

[0055] Referring again to Figure 17, at first manufacturing facility 102, two wheels 32 may be provided as attachments to transaxle 26. Drive linkage 36 may also be provided between engine 24 and transaxle 26 as part of module 90 or as part of the final connections between other selected modules at first manufacturing facility 102. Such drive linkage 36 is used to provide the

actual driving means between engine 24 and transaxle 26. At second manufacturing facility 104, handle 30 is provided and attached to implement 20 to complete assembly for transportation and sale.

[0056] Shown in dashed lines in Figure 15, since it is not a required step of manufacturing, is packaging (block 88) and transporting (block 126) the substantially completed implement to the sales facility, such as, for example, a wholesaler, a retailer, or a manufacturer's dealer, or directly to the customer, as through, for example, an Internet sales web site.

[0057] While this invention has been described as having exemplary processes, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.